

WHAT IS CLAIMED IS:

1. A phosphor comprising a material having a formula of  $AB_3O_6:Ce,Mn$ , wherein A is at least a rare-earth metal other than cerium.
2. The phosphor according to claim 1, wherein A is selected from the group consisting of gadolinium, scandium, yttrium, lanthanum, samarium, terbium, lutetium, and combinations thereof.
3. The phosphor according to claim 1, wherein A is a combination of gadolinium and yttrium.
4. The phosphor according to claim 1, wherein A is gadolinium.
5. The phosphor according to claim 1, wherein each of cerium and manganese is present in said phosphor in an amount from about 0.01 to about 30 mole percent of a total amount of A, cerium, and manganese.
6. The phosphor according to claim 1, wherein each of cerium and manganese is present in said phosphor in an amount from about 0.1 to about 10 mole percent of a total amount of A, cerium, and manganese.
7. The phosphor according to claim 1, wherein each of cerium and manganese is present in said phosphor in an amount from about 0.1 to about 5 mole percent of a total amount of A, cerium, and manganese.
8. A phosphor comprising a material having a formula of  $(Gd_{1-x-y}Ce_xMn_z)B_3O_6$ ; wherein  $0 < x, y, z < 1$ ;  $0 < 1-x-y < 1$ ; and  $(2/3)z \leq y \leq z$ .
9. A phosphor comprising a material having a formula of  $(Gd_{0.97}Ce_{0.015}Mn_{0.015})B_3O_6$ .

10. A phosphor blend comprising: (a) a phosphor having a formula of  $AB_3O_6:Ce,Mn$ , wherein A is at least a rare-earth metal other than cerium; (b) a red light-emitting phosphor; and (c) a blue light-emitting phosphor.

11. The phosphor blend according to claim 18, wherein the phosphor blend further comprises a green light-emitting phosphor.

12. A phosphor blend comprising: (a) a phosphor having a formula of  $AB_3O_6:Ce,Mn$ , wherein A is at least a rare-earth metal other than cerium; (b)  $(Ba,Sr,Ca)MgAl_{10}O_{17}:Eu^{2+}$ ; (c)  $(Y,In)BO_3:Eu^{3+}$ ; and (d)  $Y_2O_3:Eu^{3+}$ .

13. The phosphor blend according to claim 12, wherein the phosphor of (a) has a formula of  $(Gd_{0.97}Ce_{0.015}Mn_{0.015})B_3O_6$ .

14. A method for making a phosphor, the method comprising:

(a) mixing oxygen-containing compounds of: (1) boron; (2) at least a rare-earth metal other than cerium; (3) cerium; and (4) manganese to form a mixture; and

(b) firing the mixture in a reducing atmosphere at a temperature in a range from about 900 C to about 1300 C for a time sufficient to convert the mixture to the phosphor.

15. The method according to claim 14; wherein said at least a rare-earth metal other than cerium is selected from the group consisting of gadolinium, scandium, yttrium, lanthanum, samarium, terbium, lutetium, and combinations thereof.

16. The method according to claim 14, wherein the mixture further comprises at least a material selected from the group consisting of lithium tetraborate, lithium carbonate, hydrogen borate, alkali hydroborate, and mixtures thereof.

17. A method for making a phosphor, the method comprising:

- (a) providing a first solution that comprises compounds of: (1) boron; (2) at least a rare-earth metal other than cerium; (3) cerium, and (4) manganese;
- (b) combining the first solution and a second solution, the second solution comprising at least a compound selected from the group consisting of ammonium hydroxide; hydroxides of at least one element selected from the group consisting of cerium, manganese, and said at least a rare-earth metal other than cerium; organic esters; organic dicarboxylic acids; phosphoric acid; and organic amines to produce a precipitate;
- (c) heating the precipitate in an oxygen-containing atmosphere at a temperature in a range from about 700 C to about 1300 C for a time sufficient to convert the precipitate to an oxygen-containing material that comprises said cerium, manganese, and said at least a rare-earth metal other than cerium; and
- (d) firing said oxygen-containing material in a reducing atmosphere at a temperature in a range from about 900 C to about 1300 C for a time sufficient to convert said oxygen-containing material to the phosphor.

18. The method according to claim 17; wherein said at least a rare-earth metal other than cerium is selected from the group consisting of gadolinium, scandium, yttrium, lanthanum, samarium, terbium, lutetium, and combinations thereof.

19. A method for making a phosphor, said method comprising:

- (a) providing a first solution that comprises compounds of: (1) at least a rare-earth metal other than cerium; (2) cerium, and (3) manganese;
- (b) combining the first solution and a second solution, the second solution comprising at least a compound selected from the group consisting of ammonium hydroxide; hydroxides of cerium, manganese, and said at least a rare-earth metal other than cerium; organic esters; organic

dicarboxylic acids; phosphoric acid; and organic amines to produce a precipitate;

- (c) heating the precipitate in an oxygen-containing atmosphere at a temperature in a range from about 700 C to about 1300 C for a time sufficient to convert the precipitate to an oxygen-containing material that comprises said at least a rare-earth metal other than cerium, cerium, and manganese;
- (d) combining said oxygen-containing material with at least an oxygen-containing compound of boron to form a mixture; and
- (e) firing said mixture in a reducing atmosphere at a temperature in a range from about 900 C to about 1300 C for a time sufficient to convert said oxygen-containing material to the phosphor.

20. The method according to claim 19; wherein said at least a rare-earth metal other than cerium is selected from the group consisting of gadolinium, scandium, yttrium, lanthanum, samarium, terbium, lutetium, and combinations thereof.

21. A light source comprising:

- (a) a source of UV radiation that is located in a sealed housing; and
- (b) a phosphor disposed within the sealed housing and adapted to be excited by the UV radiation and to emit visible light, wherein the phosphor comprises a material having a formula of  $AB_3O_6:Ce,Mn$ , wherein A is at least a rare-earth metal other than cerium.

22. The light source according to claim 21, wherein said at least a rare-earth metal other than cerium is selected from the group consisting of gadolinium, scandium, yttrium, lanthanum, samarium, terbium, lutetium, and combinations thereof.

23. The light source according to claim 21, wherein said at least a rare-earth metal other than cerium is a combination of gadolinium and yttrium.

24. The light source according to claim 21, wherein said at least a rare-earth metal other than cerium is gadolinium.

25. The light source according to claim 21, wherein the source of UV radiation is a mercury gas discharge.

26. A display comprising:

(a) a source of radiation that is located in a sealed housing, said radiation comprising high-energy electrons; and

(b) a phosphor disposed within the sealed housing and adapted to be excited by the radiation and to emit visible light, wherein the phosphor comprises a material having a formula of  $AB_3O_6:Ce,Mn$ , wherein A is at least a rare-earth metal other than cerium.